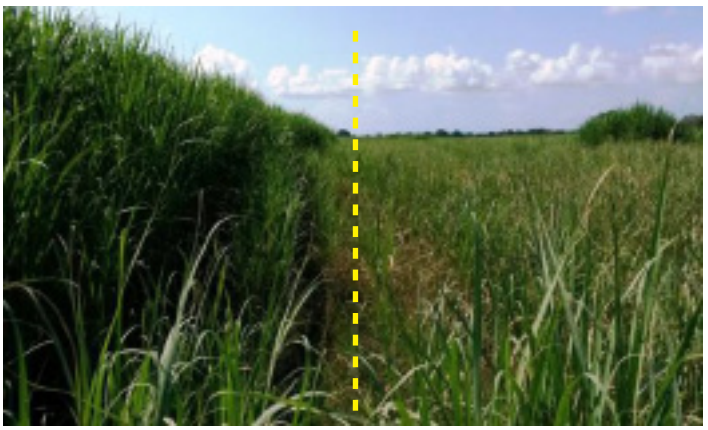
Information Sheet

7.4 Phosphorus Management

Phosphorus (P) is taken up in much lower concentrations than either nitrogen (N) or potassium (K), but is critical for a successful crop. Typically, a 100 tc/ha sugarcane crop removes about 20 to 25 kg P/ha (about 0.2 – 0.25 kg P/ton cane). In general, the sugarcane growing soils in South Africa are considered P deficient and fertiliser is required to ensure optimal crop productivity. Phosphorus is required for root formation and is thus essential for the development of strong, vigorous root systems, as well as, for proper tillering and for crop maturation. It is used in cell division and protein formation and has several biochemical functions in photosynthesis, respiration and energy transfer. Phosphorus is prone to lock-up (immobilisation) in the soil and thus careful management to optimise crop uptake is necessary.

Deficiency symptoms

- Symptoms appear on older leaves first, with leaves turning dark or blue-green to yellow, with reddening/purpling of leaf margins in severe deficiency.
- Leaves become stunted and are thinner and shorter than normal.
- Older leaves turn yellow and die-back from the tips and margins.
- Stalks tend to exhibit shorter internodes.



P soil test = 22 kg/ha **P soil test = 4 kg/ha**

Deficiency often presents as a reddening or purpling of leaf margins (above). Deficient soil P can lead to reduced crop growth (right). ▶

Impact of excess phosphorus

Specific toxicity of excess P is unknown but excess P in the soil is reported to lower sucrose content and can lead to immobilisation of other essential nutrients, notably zinc (Zn) and iron (Fe) due to the formation of plant unavailable compounds.

Factors affecting phosphorus availability

The two main processes that lock-up P and reduce availability to plants are sorption (which is when P is held by the surface of soil minerals, often very tightly) and precipitation (of the formation of solid compounds of P with other soil elements, like Ca, Mg, Fe and Zn, leading to the formation of plant unavailable compounds). Maximum availability typically occurs between pH 5 to 6, but this range can vary depending on texture, organic matter content, and the specific amount and form of Fe, Al and Ca in the soil. At a given pH, sandy soils tend to have a lower capacity to lock-up the P when compared to a clay soil.

Permanent P losses are mostly linked to sediment wash and erosion of soil particles that have P attached to them. Apart from losing valuable P for crop growth, erosion loss is considered the greatest contributor to P (and N) pollution of water bodies, such as dams, rivers and ponds (called eutrophication or nutrient enrichment).

In some situations where excessively high amounts of P are applied to a soil (often as animal manures or litter at high rates and for many years) there is increased likelihood of P leaching through the soil profile, along with higher risk for run-off losses. This tends to be more common on sandy soils.

▲ Test phosphorus availability by regularly sampling your soils. The FAS Agricultural Lab offers phosphorus analysis as part of their routine soils analysis package.

Phosphorus recommendations

Like for other nutrients, P recommendations have been based on numerous response trials run in the sugar industry for many years and calibrated against soil tests. However, due to the complex behaviour of P in the soil, identifying a single chemical extractant for use in routine testing has been diffcult, with no single extraction providing the best answer for all conditions.

FAS Agricultural Analytical Laboratory

In recent years, there have been several adaptations of laboratory methods in an effort to improve on our ability to predict P requirements over a very wide range of soil types. The method that has been adopted most recently by the FAS Agricultural Laboratory at SASRI is the anion-exchange resin-strip method. This technique aims to mimic the processes that occur between the P in the soil and the ability of the root to access and take-up the available P. It provides a good indication of the short to medium-term P requirements of the crop. It has been found to work well across most soil type regardless of pH and is thus well suited to the wide range of soil types under sugarcane. However, it does not reflect less available forms of P that may become available during the full ratooning crop cycle (long-term P availability and soil capital) thus regular soil and leaf testing is advised to monitor P adequacy levels over time.

The application recommendations and guidelines provided by SASRI and that appear in your FAS fertility report thus consider the resin extractable soil test value which is compared to the appropriate threshold for the soil type. The amount of P fertiliser required to increase the soil test value to the threshold is given as the P fertiliser recommendation.

Phosphorus application guidelines

Practical application considerations for plant and ratoon cane are provided below.

Plant cane

The most opportune time to ensure adequate P for the plant and subsequent ratoon crops is at planting. The following general guidelines apply.

- Select a readily available source of P (e.g. MAP, super phosphate) for optimal results.
- Apply the recommended P rate in the bottom of the furrow or ripline at planting.
- Avoid applying the P fertiliser directly on the setts as this may cause salt damage to emerging roots, especially where high rates are required or other fertiliser are to be included in the application (N and K fertilisers).
- Ensure P is buried/covered after application (do not leave on soil surface).
- A minimum of between 20 and 40 kg P/ha will typically be recommended depending on the soil test value.
- A maximum of 80 to 100 kg P/ha in a single furrow application is permitted.
- Where soil test P is very high, then no P is advised.
- Ensure that you account for other P sources (e.g. manures) when determining your P-fertiliser application rates.

▲ Fertiliser applied into the furrow.

Ratoon cane

The low mobility of P from surface applications reduces the value of ratoon topdressings in that growing season. However, where soil or leaf diagnostics indicate the need for additional P, the following strategies should be considered:

- In ratoon cane, 10 to 20 kg P/ha is advised if the soil test is below the threshold value and no P is advised if the soil test is above the threshold value.
- Ideally, knife P into the soil as a side dressing to a 10 - 20 cm depth at a distance of 10 - 20 cm from the stool line. This, however, requires specialised implements and must be done with care to avoid unnecessary root or stool damage.
- Where a knifed side dressing is not possible, P can be applied in shallow (10 - 20cm depth), interow riplines.
- Where green cane harvesting is practised and the residues mulched, P can be applied to the mulch layer (avoid bare soil surfaces) on either side of the stool lines, ideally coinciding with suffcient rainfall to flush P to the soil surface.
- When none of the above is possible, surface apply the P directly on or adjacent to the emerging cane line. This, however is of limited value for the crop in that season, though will contribute to P capital in future seasons. This P will be susceptible to erosion losses.

Management strategies that improve the efficiency of P use by the crop

- As P can be strongly fixed in soils, the main concern is to ensure that suffcient P remains available to the crop. As a general rule it is best to apply the P at planting, supplying adequate amounts to support subsequent ratoon growth.
- Top dressed application in ratoons is generally not effcient, though may have benefit where soil P tests are low and the P can be knifed or band applied and covered/buried after application.
- In more acidic soils (pH < 6) that have high P fixation capacity (typically humic soils), the P capital of the soil can be increased through broadcast application of additional P (over-and-above the recommended rates). This can be achieved using crushed, low solubility rock phosphates and apatites or P-rich manures (with equivalent P rates of 50 to 100 kg P /ha) that are broadcast and incorporated. In the case of rock-phosphates, the effect will only become evident after several seasons with limited benefit to the crop immediately following the broadcast application.
- In alkaline and calcareous soils, there is limited value in rock phosphates (as they do not dissolve) so more soluble P forms are required, and should be used in conjunction with acidifying fertilisers (such as ammonium sulphate) to promote dissolution of P-Ca complexes. Inclusion of mulches and organic material will also promote release of P in these soils. Furrow/banded application remains the preferred application strategy.
- Ensuring good soil health (amelioration of root limiting constraints) is also important for a healthy root system that can extend and explore more widely in the soil as well as form beneficial associations with micro-organisms. This increases the likelihood of the plant encountering and taking up the P in the soil.

Precautions for P use

- Excessive P application rates can lower tilliering and sucrose content – adhere to application recommendations.
- Excess P can lead to, in particular, Zn and occasionally Fe deficiency due to formation of plant unavailable phosphate compounds. Where a high rate of P is required, it is advisable to use a Zn fortified P fertiliser or apply supplemental Zn.
- Surface applied and uncovered P is prone to run-off and erosion losses, especially on steeper slopes and under high intensity rainfall events. This will lead to a permanent loss of P from the field and result in pollution of water bodies and rivers. This must be avoided.

Available phosphorus fertiliser formulations

P-Products	P%	Other%	General Notes	Application notes
Single super phosphate(SSP)	8-11	Ca:20-22S:10	• Soluble P, supplies Ca, S. • High cost P.	Furrow application at planting is best.
Double/triple super phosphate (DSP/TSP)	20	Ca:15-18	• Soluble P, supplies Ca. • High cost P.	
Ammoniated super phosphate (ASP)	12	N:4S:10	• N and P together. • Acidifying, expensive N.	
Mono ammonium phosphate(MAP)	22	N:11	• N and P together, cheap P. • Acidifying, expensive N.	
Di ammonium phosphate(DAP)	20	N:18	• N and P together, cheap P. • Acidifying, expensive N.	
Rock phosphates/ apatites	Variable	Ca: variable Mg: variable	• Relatively low cost, some acid neutralising value, supplies Ca and Mg, may qualify as organic P fertiliser source. • Low solubility.	• Broadcast on acid soils to build P capital. • Usually a soluble P source is also required for short term crop needs.
Bone meal				

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